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# Radiation Therapy for Early Stage Lung Cancer

Focus on Lung Cancer and Related Disorders  
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Alexander Lin, M.D.  
Assistant Professor  
Department of Radiation Oncology  
University of Pennsylvania



# Outline

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- Background
- Past: Conventional Radiation Therapy
- Present: Stereotactic Radiation Therapy
- Future: Proton Therapy



# Radiation 101

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- What exactly is radiation therapy?
  - High energy x-rays
- How does it work?
  - Deposited energy → DNA damage
  - DNA damage → Cell death
    - Tumor cells → response → control/cure
    - Normal tissues → toxicity/complications



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Tumor

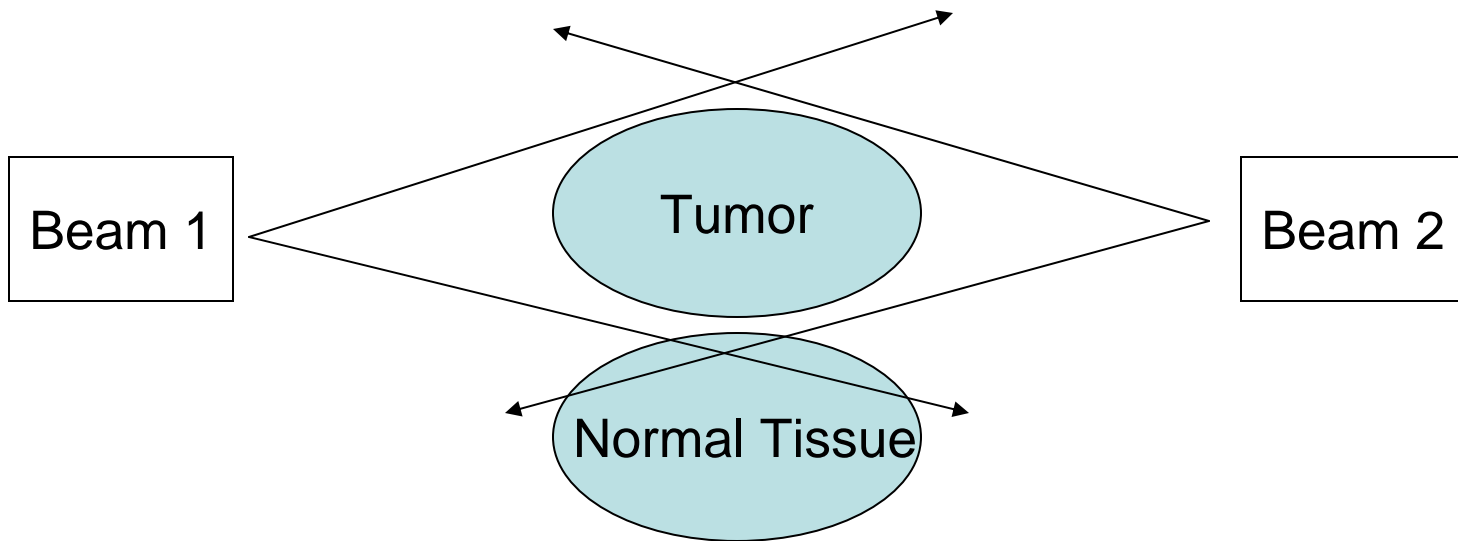


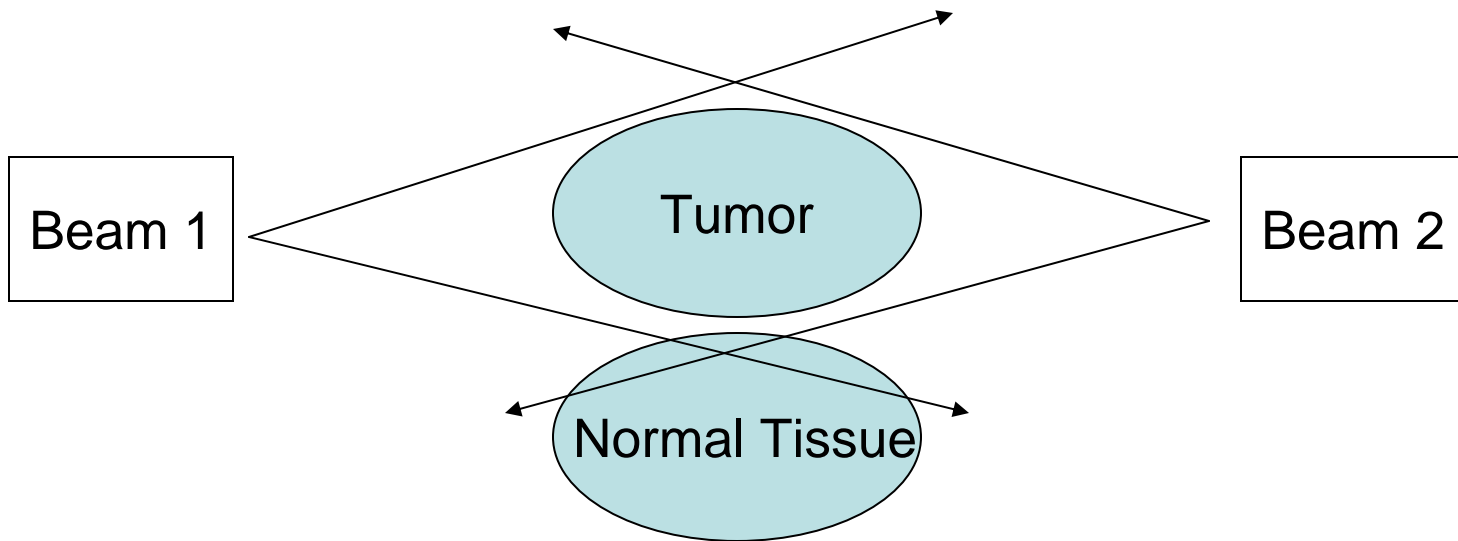
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Tumor

Normal Tissue







# Radiation Treatment Planning

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# Radiation Therapy for Early Stage Lung Cancer: Indications

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- Surgery: treatment of choice
- Radiation: Reserved for those who cannot tolerate surgery (poor pulmonary function, cardiac dysfunction, vascular disease, etc)
  - Long term results of surgery superior to conventional radiation
  - 6-8 week course, 5 days/week
  - 60-80 Gray total dose



# Drawbacks of Conventional Radiation

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- Inconvenient
- Cure rates suboptimal
  - Surgery: 60-70%
  - Conventional Radiation: 10-30%
    - Disease recurrence within the radiation field common
- Rationale for results with radiation?
  - Inadequate dose
  - Inadequate technique





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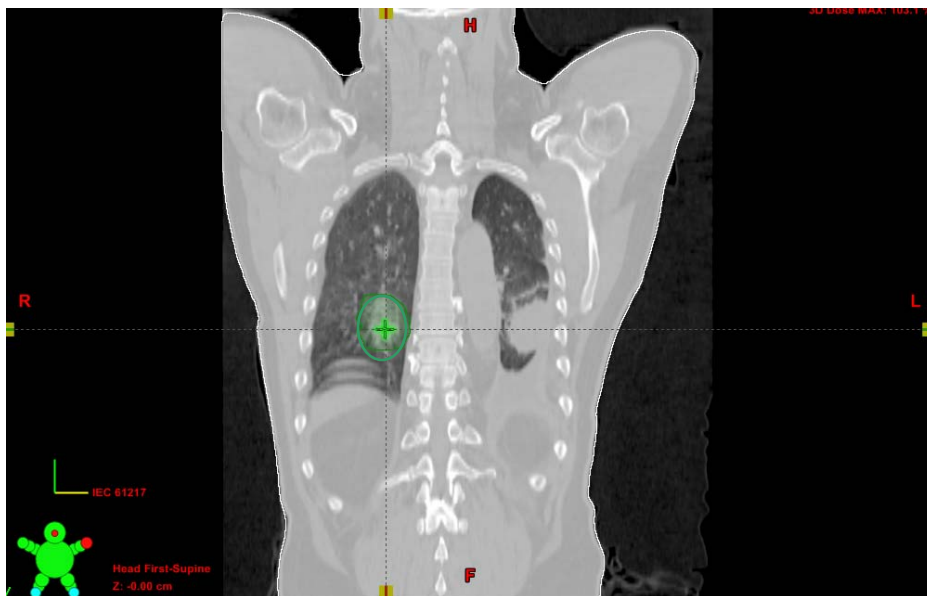
# Stereotactic Radiation Therapy

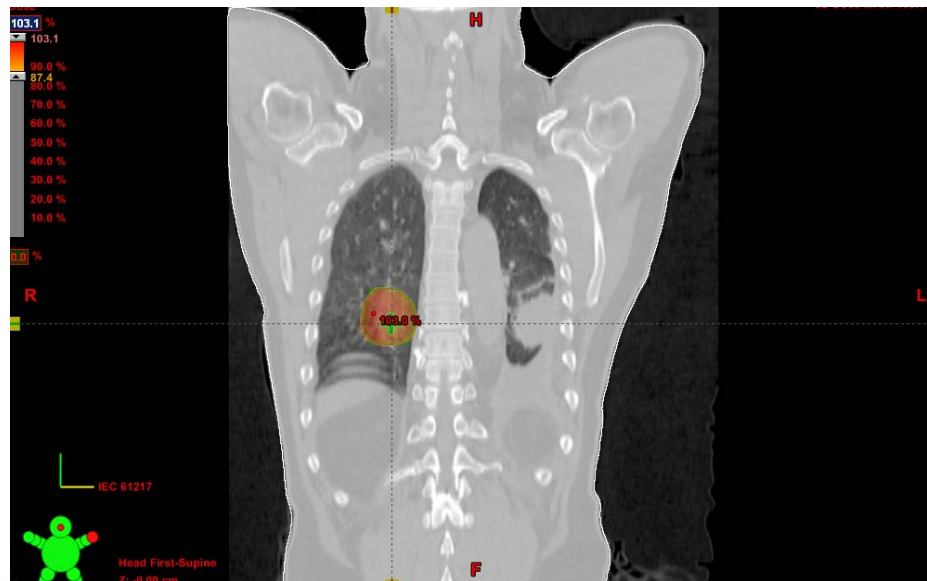
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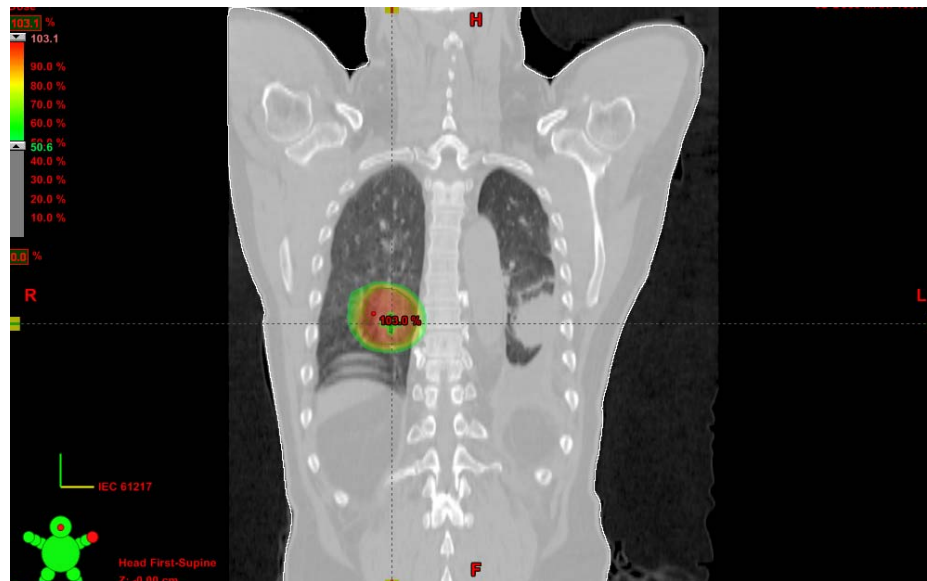
- Accurate
  - 4-dimensional CT scan (tumor motion)
  - Accuracy on order of millimeters
  - Verification at time of each treatment
- Convenient
  - 3 total treatments (versus 30-40)
  - 1-2 weeks (versus 6-8)
- Biologically superior
  - 20 Gray per treatment (1.8 – 2 Gray with conventional therapy)
- Results promising
  - 95% local control rate at 2 years











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# Proton Therapy

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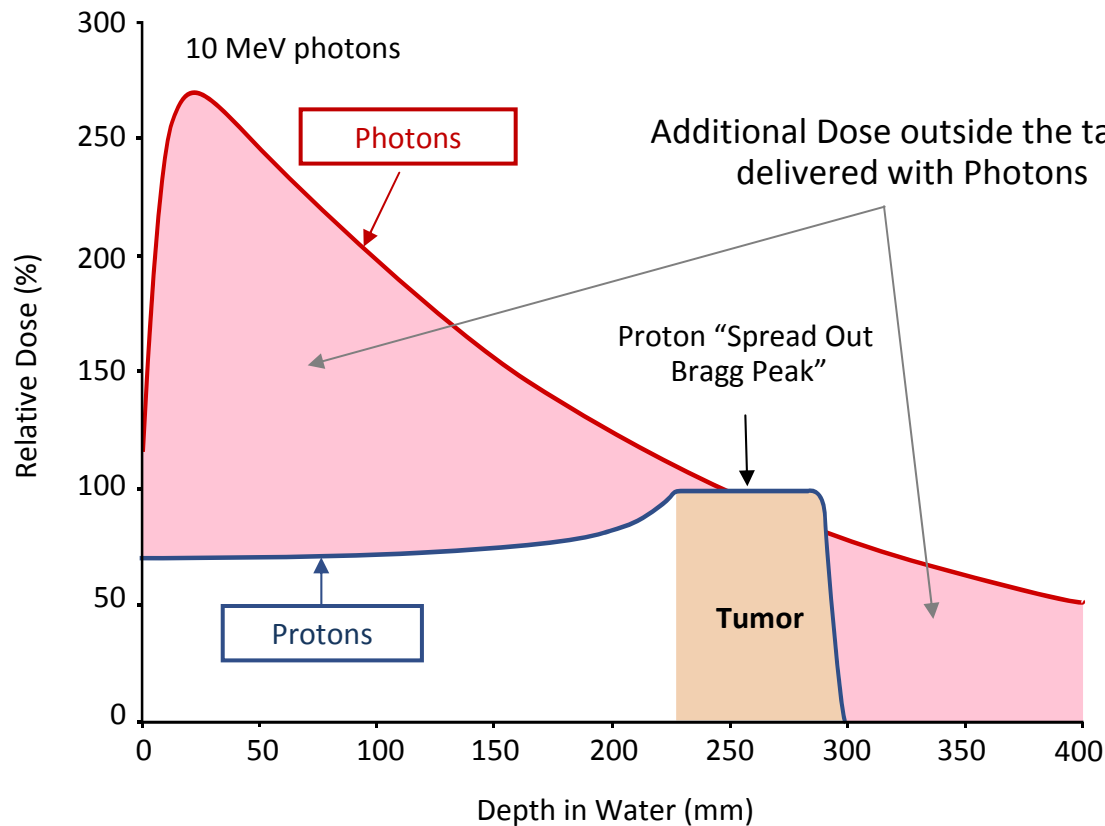
**Perelman Center for Advanced Medicine, Roberts Proton Therapy Center**

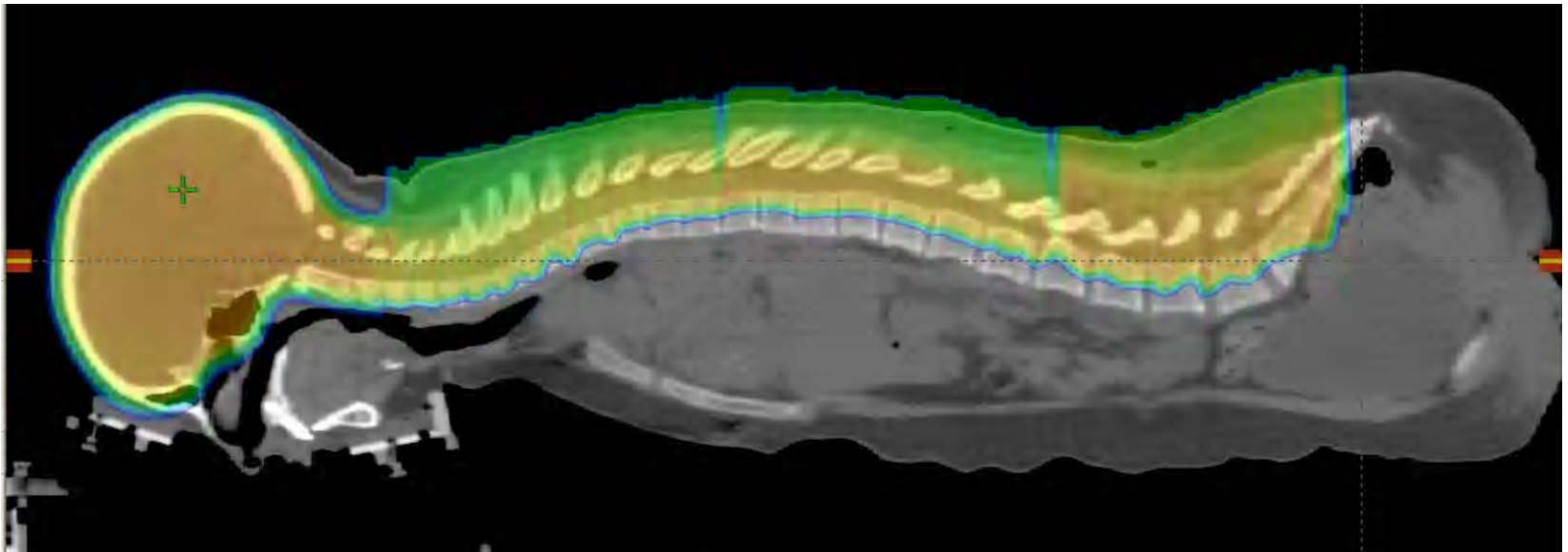
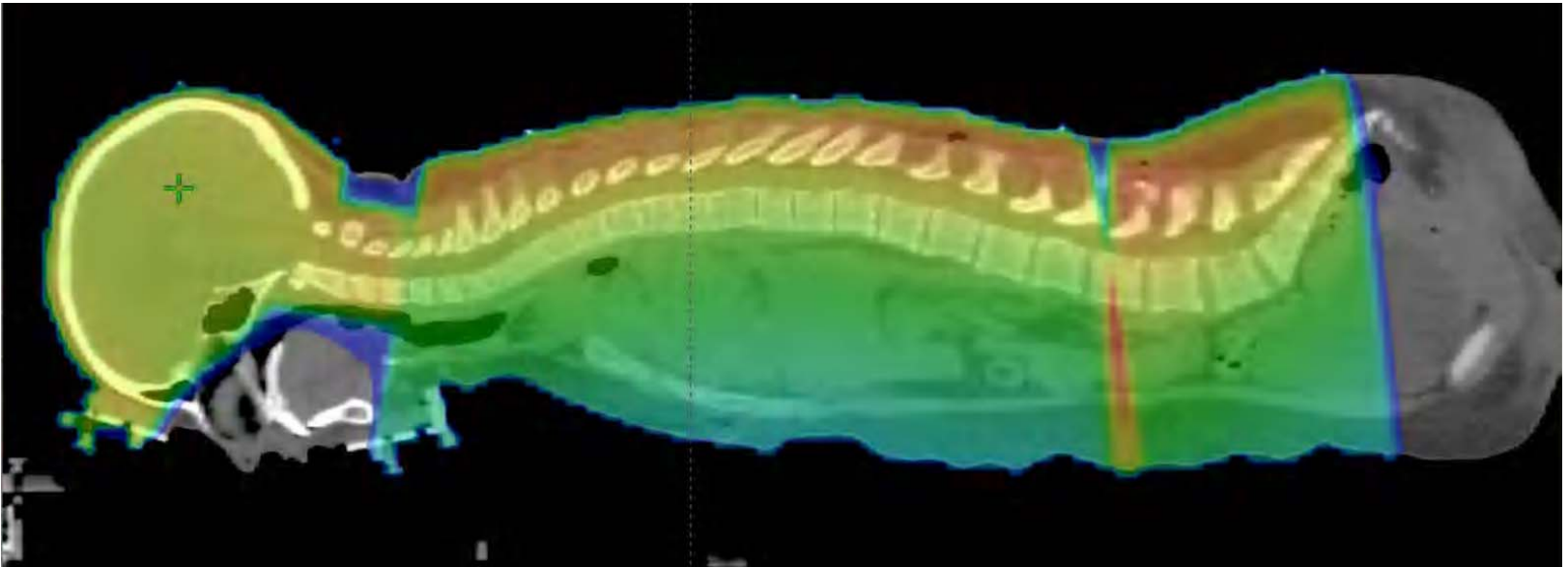


# The Physics of Protons

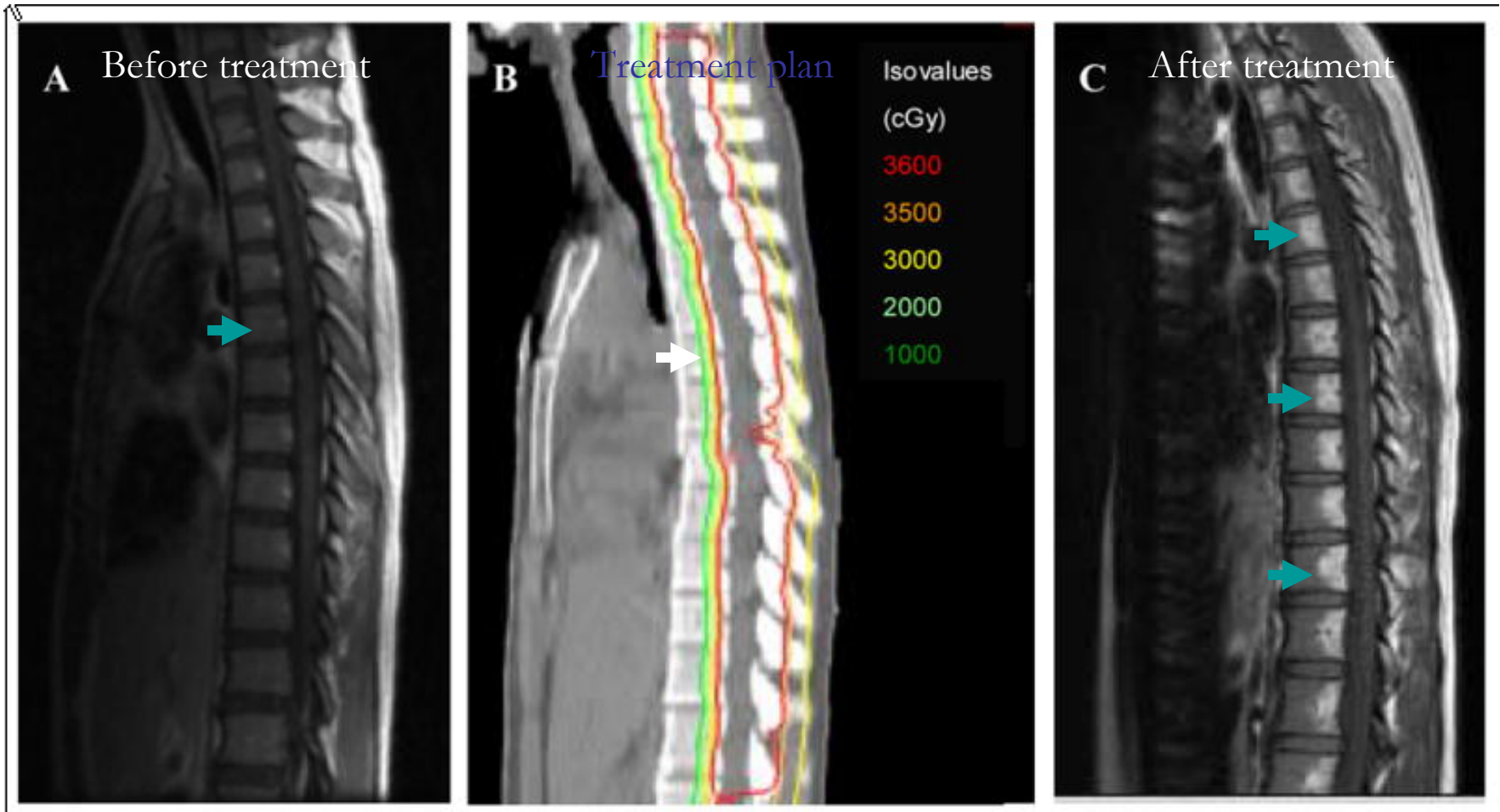
X-rays deliver a greater dose outside the target for the same dose within the target volume as protons

Depth dose curves for protons and photons





# Evidence of Distal Range Stopping



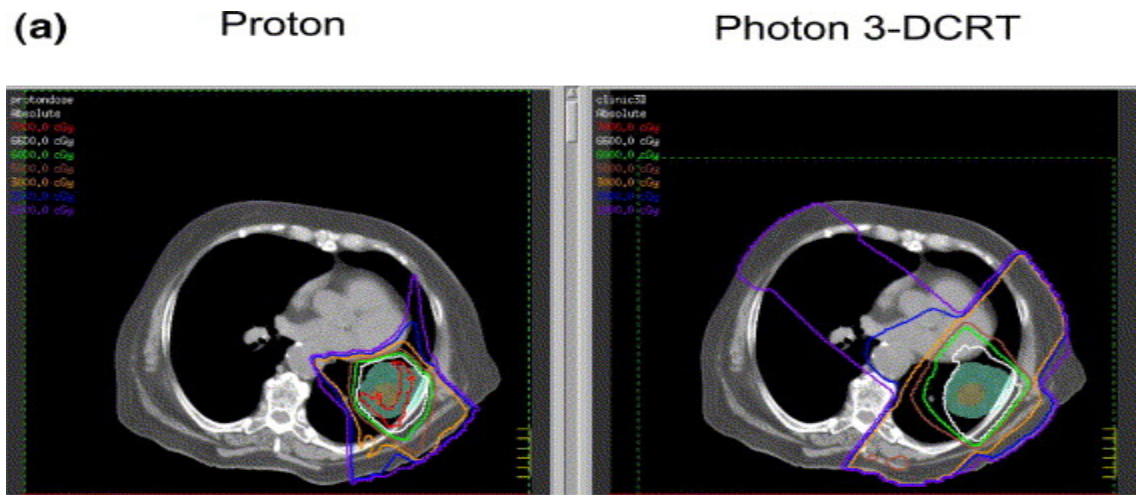
Stephanie C. Krejcarek, B.Sc.,<sup>1</sup> P. Ellen Grant, M.D.,<sup>2</sup> John W. Henson, M.D.,<sup>2,3</sup> Nancy J. Tarbell, M.D.,<sup>1</sup> and Torunn I. Yock, M.D., M.C.H.<sup>1</sup>



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# Stage I T1N0M0 NSCLC 66 Gy

- 3D X-Ray vs. Proton
- Every avoidance structure received less dose with Proton



- Chang et al, IJROBP 2006



# Conclusions

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- Radiation Therapy for Early Stage Lung Cancer: best for those who cannot undergo surgical resection
- Conventional techniques and fractionation
  - Suboptimal results, biologically inadequate
- Stereotactic radiation therapy:
  - Few fractions, high dose per fraction
  - New standard?
- Proton Therapy
  - Potential for escalation of dose, sparing of normal tissues



# Go Phillies!

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